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Immediate effects of Kinesio taping and Dynamic taping on acromiohumeral distance in individuals with symptomatic rotator cuff tendinopathy

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ABSTRACT

Background: It has been suggested that the reduction in subacromial space during arm elevation is one of the potential mechanisms in the etiology of Rotator cuff tendinopathy. While it is known that Kinesio taping reduces the narrowing of the acromiohumeral distance (AHD) during arm elevation, the effect of Dynamic taping remains unknown.
Purpose: This study aimed to compare the immediate effects of Kinesio taping and Dynamic taping on AHD in individuals with symptomatic Rotator Cuff Tendinopathy.
Study Design: Two group pre-post-test repeated measures design was used.
Methods: Thirty-two participants were randomly assigned to two groups: Kinesio taping group (n = 16) and Dynamic taping group (n = 16). AHD measurements were taken via ultrasound at 0° (rest) and 60° shoulder abduction both before and immediately after taping. Repeated measures ANOVAs were used for statistical analyses.
Results: The study demonstrated that both taping methods led to a significant increase in AHD at both neutral and 60° abduction. However, the increase in AHD with Dynamic taping was statistically greater than with Kinesio taping in both neutral ($p < 0.05$) and 60° abduction ($p < 0.001$).
Conclusions: The findings of this study suggest that Dynamic taping techniques may be a more effective approach for improving AHD for symptomatic patients. Therefore, Dynamic taping has the potential to be clinically beneficial before engaging in exercises.

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Introduction

Rotator cuff tendinopathy is defined as an umbrella term that encompasses a number of shoulder conditions, including subacromial pain (impingement) syndrome and symptomatic partial and full thickness rotator cuff tears. Generally, the common symptom is pain when raising the arm due to increased compression within the subacromial structures. [1] The reduction in subacromial space during arm elevation is influenced by various intrinsic and extrinsic factors. However, conclusive evidence is lacking to determine whether the increased subacromial narrowing is the cause or the result of rotator cuff tendinopathy/impingement. [2]

The subacromial space is quantified as the Acromiohumeral Distance (AHD), which signifies the minimal space between the undersurface of the acromion and the top of the humeral head. [3] Research has shown that individuals with Rotator Cuff Tendinopathy (RCT) symptoms generally exhibit smaller AHD values during arm elevation compared to individuals without pain and those with no shoulder issues. [4,5] Typically, in individuals without symptoms, AHD measures between 9 and 12 mm, though these values can vary depending on factors such as age, gender, specific shoulder conditions, arm position, and the measurement methods used. [6]

Considering these factors, physiotherapists employ various interventions to enhance AHD during shoulder rehabilitation. Prior research has explored the immediate effects of different elastic or rigid taping application on shoulder or scapula on AHD. [7–14] Kinesio taping (KT), one of the elastic tapings, is widely used in clinical practice [15] and it's shown to reduce narrowing of the AHD on arm

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elevation in the symptomatic shoulder. [9] However, the physiological mechanism behind this is unclear. Potential mechanisms are changes in neuromuscular activation with deltoid inhibition and mechanical correction, such as the reduction of humeral superior translation to improve its alignment within the glenoid cavity. [9]

Dynamic tape (DT) represents a relatively new therapeutic taping approach introduced in 2009 by Ryan Kendrick. There are a limited number of studies on DT have been published in the literature. [16–20] DT offers structural differences compared to KT. While KT can stretch longitudinally up to 140% of its original length, [21] DT can stretch in multiple directions (both transverse and longitudinal) exceeding 200%. Additionally, DT possesses robust elastic recoil and lacks a rigid endpoint, combined with viscoelastic properties. [22] Therefore, it is thought that the advantageous structural features of DT may have a positive effect on AHD. Hence, the aim of this study was to compare the immediate effects of DT and KT on AHD at different arm positions in individuals with RCT. We hypothesized, based on the theoretical background, that the immediate effects of DT are better than those of KT.

Methods

Study design and procedure

A one-group pre-post-test repeated measures design was used to compare the effects of taping application on AHD in individuals with symptomatic RCT. First, measurements were taken without taping. Thereafter, KT or DT was applied on the symptomatic shoulder, and the same measurements were taken again. Only the symptomatic shoulder of each participant was taped and evaluated. Each participant had ultrasound measures of AHD taken before and after the initial KT or DT application, in 0° and 60° of active shoulder elevation in the scapular plane. Participants remained unaware of both the type of taping and the procedures applied to participants in the other group. Taping techniques were applied by an investigator who had more than five years' experience as a musculoskeletal physiotherapist. AHD was measured by other examiner who had more than 10 years of experience with ultrasound.

The research took place from June 2021 to October 2021 at Muğla Training and Research Hospital. Ethical clearance was granted by the Health Sciences Ethical Committee of Muğla Sıtkı Koçman University (09.06.2021/122). The study adhered to the ethical principles outlined in the Declaration of Helsinki. All participants were informed about the study's details and signed an informed consent form. It was made clear that they had the freedom to withdraw from the study at any time.

Participants

A total of 32 participants, both male and female, were enrolled in the study and were randomly assigned to either the Dynamic taping group (n = 16) or the Kinesio taping group (n = 16). Randomization was carried out by an independent researcher using a computer-based random generator prior to the study's commencement. The eligibility of patients for the study was determined by the physician.

The inclusion criteria were as follows:

- Pain duration > 6 weeks.
- Age between 18 and 65 years.
- Presence of at least two positive signs from the following three categories: (1) Neer or Hawkins-Kennedy test, (2) painful arc of movement, and (3) pain during resisted abduction, external rotation, or empty can test.

The exclusion criteria were as follows:

- Open wound on the shoulder.
- Massive rotator cuff tear, long biceps head tendon tear (It was determined by the physician with ultrasonography while being diagnosed).
- History of shoulder-related surgery or fracture.
- Allergy or intolerance to taping (A small piece of tape was applied to the asymptomatic shoulder, and any allergic reactions were observed for five minutes).
- Presence of adhesive capsulitis, cervical radiculopathy, rheumatic, or neurological disease.
- Receipt of steroid injections within the last three months before the study.

Measurement of acromiohumeral distance

AHD was measured using an ultrasound scanner (Toshiba Aplio 500) equipped with a 7–12 MHz linear array probe by a radiologist. Ultrasound imaging is a dependable technique for measuring AHD (Intraclass Correlation Coefficient (ICC) = 0.98 [0.97–0.99], Minimum Detectable Change (MDC) = 0.70 mm). [23] Measurements were conducted in two arm positions: at rest (0°) and at 60° of shoulder abduction. Initially, measurements were taken at rest, with the arm in a neutral position beside the body, elbow extended, and participants seated upright. Following this, measurements were acquired with the arm abducted at a 60° angle, the elbow extended, and the palm facing downward. The accuracy of this angle was verified before each measurement using an inclinometer, a validated and reliable method for assessing shoulder angles [24] (Figs. 1 and 2). Each arm position underwent three trials, and the average of these three measurements was recorded.

Kinesio taping techniques

After disinfecting the skin with alcohol, a standard blue Kinesio Tex Classic tape was applied to the symptomatic shoulder following a technique developed for rotator cuff tendinopathy (RCT). [21,25] This technique involved three phases:

1. Slight tension (~25%) Y-taping encircling deltoid muscles from insertion to origin.
2. I-shaped taping with high tension (~75%) from just above the acromioclavicular joint to below the deltoid tuberosity.
3. Horizontal I-taping with high tension (~25%) from the coracoid process to the posterior deltoid, just below the coracoacromial arch, for mechanical correction at the glenohumeral joint.

The taping was conducted with the participant seated upright in an armless chair with feet on the floor and the arm free. A single physiotherapist applied all the taping, adhering to the principles outlined by Kase et al. [21] While measuring AHD with KT, a portion of the tape from the second stage was cut to allow the ultrasound probe to be placed between the humerus and acromion (Fig. 3).

Dynamic taping techniques

After sanitizing the skin with alcohol, Dynamic Tape Eco was employed on the symptomatic shoulder using the Upper Limb Offload technique. Dynamic Tape Eco has a greater resistance yet slightly less recoil compared to Dynamic Tape Classic. The Upper Limb Offload technique is among the direct methods where the body part is placed in its shortened state. This technique encompasses three taping procedures as outlined below:

Fig. 1. Measurement of acromiohumeral distance with ultrasound.

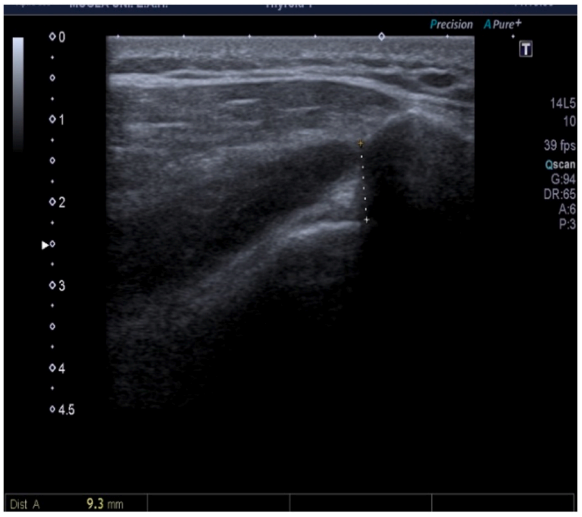

Fig. 2. Calculation of acromiohumeral distance on ultrasound image.

1. The participant's shoulder is extended to 30º, and the tape is affixed to the posterior of the humerus without tension. Subsequently, the tape passes over the acromioclavicular joint with gentle tension and concludes without tension.
2. The participant's shoulder is flexed to 90º. The tape adheres to the biceps without tension and then extends from the superior aspect of the shoulder to the acromioclavicular joint with slight tension.
3. In the third and final taping, commencing from the anterior shoulder, a short tape is applied by applying tension beneath the acromion towards the posterior humerus. This taping contributes to mechanical correction for the humeral head.

The taping occurred with the participant seated in an armless chair in an upright position, with their feet on the floor and their arm unrestricted. All applications were administered by the same physiotherapist following the principles outlined by Kendrick. [22] During AHD measurement with DT, portions of the first strips were cut to facilitate the positioning of the ultrasound probe between the humerus and acromion (Fig. 4).

Sample size and data analysis

The sample size calculation was carried out using the G*Power software, and it was performed for a repeated measures analysis of variance (ANOVA) with the following parameters: α (significance level) = 0.05, β (Type II error) = 0.05 (with a power of 90%), and effect size (F) = 0.70. [8] According to this calculation, it was determined that a sample size of 30 participants is necessary for a scenario involving two measurements.

Data analysis was conducted using SPSS (Statistical Package for the Social Sciences) Program for Windows, version 22.0 (SPSS Inc, Chicago, IL). Descriptive statistics were presented as mean and standard deviation or frequency [percentage (%)]. The independent samples *t*-test, Chi-Square Test (χ^2 test), and Mann-Whitney *U* test were utilized to assess and compare the baseline characteristics of the two groups. Furthermore, a repeated measures ANOVA model was applied to analyze the combined effects of the taping technique and the pre- and post-taping measurements of AHD. The intra-rater reliability of AHD measurements was evaluated by comparing the three measurements conducted at each position using ICC (two-way random model with a 95% confidence interval). The significance level was set at $p < 0.05$. An unbiased independent evaluator, specializing in biostatistics and not participating in any other aspects of the study, conducted all statistical analyses.

Results

A total of 54 patients were admitted to the physical therapy and rehabilitation clinic between June 2021 and October 2021, and 32 patients met the inclusion criteria. Patients were randomly assigned to either the DT group ($n = 16$) or the KT group ($n = 16$). No significant differences in baseline demographic and clinical characteristics were observed between the two groups ($p > 0.05$) (Table 1).

Descriptive statistics for the AHD measurements of the groups before and after taping at both angles are given in Table 2. In the DT group, within-group analysis revealed a significant improvement in AHD for both the neutral position (0°) and 60° abduction ($p < 0.001$). Similarly, within the KT group, significant improvements were observed in AHD for both angles ($p < 0.001$) (Table 2).

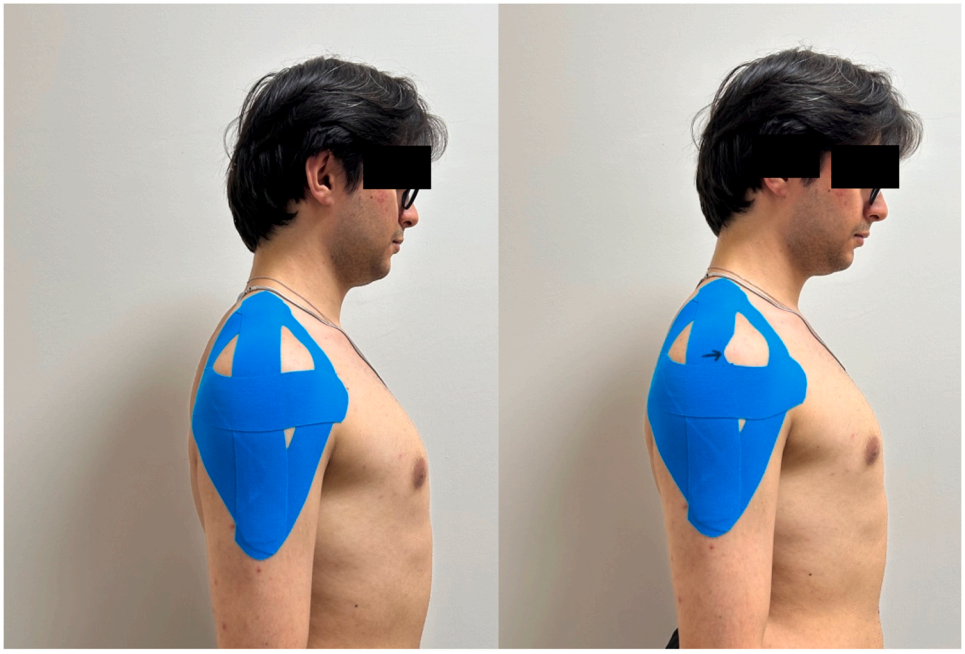

Fig. 3. Kinesio taping.

Fig. 4. Dynamic taping.

For AHD at rest, a significant interaction between condition (taping or no taping) and group was found [$F(1,30) = 10.181$, $p = 0.003$, $\eta_p^2 = 0.253$)]. DT showed a more significant increase in AHD at rest than KT (Fig. 5). Similarly, for AHD at 60° abduction a significant interaction between condition and group was found [$F(1,30) = 16.235$, $p < 0.001$, $\eta_p^2 = 0.351$)]. DT showed a more significant increase in AHD at 60° abduction than KT (Fig. 6).

The intra-rater reliability of AHD measurements was found to be excellent both before and after taping: at 0°/rest: $ICC_{Before\ taping}$ = 0.98(0.90–0.98), $ICC_{After\ DT}$ = 0.96(0.85–0.97), $ICC_{After\ KT}$ = 0.95(0.87–0.97); at 60° of abduction: $ICC_{Before\ taping}$ = 0.95(0.83–0.97), $ICC_{After\ DT}$ = 0.90(0.82–0.95), $ICC_{After\ KT}$ = 0.91(0.86–0.96).

Discussion

This study demonstrated that both DT and KT result in an immediate increase in the AHD measured by ultrasound. However, the increase in AHD achieved with DT was greater than that achieved with KT. This result supports the hypothesis we proposed.

This is the first study to compare DT and KT in increasing AHD. Previous research has examined the immediate effects of different elastic or rigid taping on AHD at the shoulder or scapula, showing that these tapes reduce the dynamic narrowing of AHD during elevation of the arm. Leong et al. (2019) observed that a rigid scapular tape had no effect on AHD at 0° shoulder abduction in athletes with

Table 1
Demographic and clinic characteristics of groups

Demographic and clinic characteristics	DT	KT	*p*-value DT versus KT
	Mean ± SD *n* = 16	Mean ± SD *n* = 16	
Age (years)	52.06 ± 7.51	44.6 ± 11.0	0.06*
Height (m)	1.67 ± 0.07	1.71 ± 0.06	0.09*
Weight (kg)	78.37 ± 16.22	77.81 ± 16.75	0.92*
Duration of symptoms (months)	6.50 ± 8.30	4.68 ± 3.89	0.74†
	n (%)	*n* (%)	*n* (%)
Gender			
Female	8(50%)	6(37.5%)	0.47‡
Male	8(50%)	10(62.5)	
Dominance			
Right-handed	16(100%)	16(100%)	
Left-handed	0	0	
Symptomatic shoulder			
Right shoulder	7(43%)	11(68%)	0.12‡
Left shoulder	9(56%)	5(31%)	

DT = Dynamic taping; KT = Kinesio taping; SD = standard deviation.
* The *p* value was obtained using an independent *t* test.
† The *p* value was obtained using Mann-Whitney *U* test.
‡ The *p* value was obtained using a x^2.

Table 2
Descriptive statistics of the acromiohumeral distance (AHD)

AHD	Dynamic taping Before taping	Dynamic taping After taping	Kinesio taping Before taping	Kinesio taping After taping
0° (at rest)	9.73 ± 1.23	11.06 ± 1.17	9.25 ± 1.38	9.83 ± 1.35
60° abduction	8.11 ± 0.89	9.48 ± 1.02	7.10 ± 0.60	7.76 ± 0.79

BT = before taping; AT = after taping; AHD_{DT} = acromiohumeral distance of Dynamic taping group; AHD_{KT} = acromiohumeral distance of Kinesio taping group.
AHD is expressed as width in millimeters. Results expressed as mean (standard deviation). The *p* value was obtained using a paired *t* test.

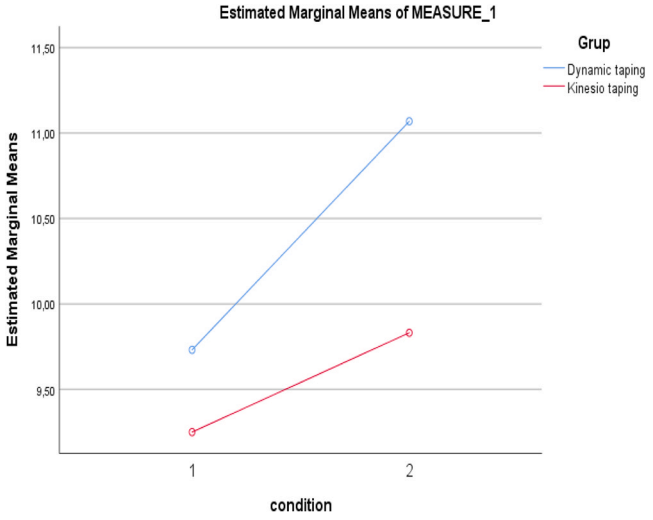

Fig. 5. AHD at rest/neutral.

RCT but provided less reduction in AHD during 60° active shoulder abduction. However, in the same study, taping did not make a difference in AHD when applied to asymptomatic shoulder. [8] This result indicates that the effect of taping on AHD may vary depending on the population (athletic, general, healthy, symptomatic). Therefore, the results of AHD studies conducted on healthy individuals should not be directly applied to a pathological shoulder. Consequently, this study investigates the impact of taping on symptomatic individuals.

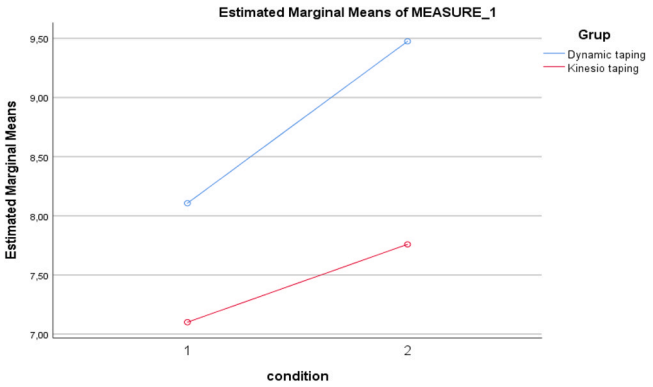

Fig. 6. AHD at 60° abduction.

There was no sham or placebo KT or DT group in the design of our study. Because previous literature has shown that a sham or placebo taping protocol can be a significant problem. [15,25] All tapes applied to the skin potentially can produce some proprioceptive feedback, serving as a confounding factor in terms of range of motion. Increased proprioceptive feedback can especially alter neuromuscular control in symptomatic shoulders.

As expected, in this study, the AHD increase was higher with DT in both arm positions. Navarro-Ledesma and Luque-Suarez et al. (2013) reported that at shoulder rest position, AHD did not change between symptomatic and asymptomatic shoulders, but especially at 60° abduction, AHD significantly decreased in symptomatic shoulders (7.4% or a 0.51 mm reduction). [9] In our study, at 60° of abduction, KT resulted in a 9.26% increase, and DT led to a 16.8% increase. Considering that the narrowing of the subacromial space in individuals with RCT may be related to the thickness of the supraspinatus tendon, [26] the increase in the subacromial space, particularly with DT, may be expected to contribute to reducing compression in subacromial structures during arm elevation. Therefore, the observed increase in AHD with both taping in our study (high from 7.4%) may have potential importance for pain relief. Bands applied before traditional physiotherapy applications can increase the patient's compliance and satisfaction with exercises by reducing pain, which can make rehabilitation protocols more effective.

The immediate effect of taping on AHD in symptomatic shoulders has been investigated in only two studies. [7,8] Leong and Fu (2019) observed an increase in AHD during arm elevation with a single bout of rigid scapular taping (Leukotape adhesive tape) and suggested that scapular taping may contribute to the increase in AHD through increasing delayed activation of the lower trapezius and improving neuromuscular control during arm elevation. [8] Olivera et al. (2019), using the same shoulder taping technique as our study, observed a 10.5% increase in AHD during arm elevation with KT, similar to our study. [7] The KT technique used by both us and Olivera et al. (2019) consists of two parts. The first part involves a muscle inhibition technique for the three parts of the deltoid, while the other part involves a mechanical correction technique for repositioning the humeral head. Lyman et al. (2017), demonstrated that the best AHD increase with KT is achieved with the muscle inhibition technique for the deltoid muscle in healthy individuals. [10] However, in both our study and Olivera's study, mechanical correction taping was added after the muscle technique for the deltoid. This was done with the expectation that it would provide better positioning of the humeral head, leading to a greater increase in AHD. However, despite all these considerations, DT provided a greater increase than KT in AHD. The "offload" technique of DT is also a combination of a muscle

technique and a mechanical correction technique. However, in the muscle technique, the first tape applied to the front of the shoulder extends up to the scapula. In this respect, it is similar to the scapular taping used in Leong's study. Extending the tape to the scapula may provide further AHD increase by regulating scapular neuromuscular muscle activation. Huang and Kim (2020) used the same DT technique as our study (upper limb offload) and demonstrated that the tape regulates the activation of specific muscles during arm elevation by inhibiting the middle deltoid and activating the upper trapezius. [27] This result supports our inference that DT can modulate neuromuscular control.

In this study, the 16.8% increase in AHD achieved with DT at 60° of abduction represents the most significant AHD increase obtained with taping applications, to the best of our knowledge. Differences in the structural features of DT or the general application technique may also be effective in this increase. DT's four-way stretch and over 200% elongation capacity are significant structural differences from KT. Furthermore, KT is typically applied with the body in an extended position, whereas DT is applied with minimal tension when the body segment is shortened, focusing on load absorption. Particularly, the "upper limb off-load" technique used in this study incorporates the principle of reducing muscle workload. Therefore, it has the potential to prevent the reduction of the subacromial space during arm elevation.

Strengths and limitations of this study

This study has certain limitations that should be acknowledged. Firstly, it solely focuses on the immediate effects of taping. While these immediate effects could be advantageous during exercise, the durability of these outcomes over the long term remains uncertain. Prolonged usage of the tapes might lead to alterations in their stretching characteristics and biomechanical support, potentially resulting in different outcomes. Another limitation is related to the methodology used for taping application. After taping, a small section of the tape is cut to allow the placement of an ultrasound probe for measuring AHD. While the technique of cutting or removing a portion of the tape is commonly employed in shoulder taping and imaging studies, the extent to which this practice affects the effectiveness of the tape is not clear.

Conclusion

This study revealed that DT provided a greater immediate increase in AHD than KT in the symptomatic shoulder, both at rest and in 60° abduction. The immediate increase in AHD, especially with arm elevation, may inhibit pain by reducing subacromial compression. This may provide an advantage to physiotherapists in exercise applications and progress of rehabilitation. However, a systematic review by Park et al. (2020) shows that evidence to determine the relationship between AHD and pain or disability is still limited. [28] Therefore, treatment of a patient with RCT should focus not only on the possible reduction in AHD but also on other biopsychosocial factors.

Ethical approval

Ethical approval was obtained from the Health Sciences Ethical Committee of Muğla Sıtkı Koçman University (Türkiye) (09.06.2021/122).

Declaration of Competing Interest

None.

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